tion. I have been more particular in this account of the use of oil of turpentine in enteric fever, because I have great confidence in the efficiency of the remedy myself, and wish to prevail on others to use it by showing the grounds of this confidence, and pointing out the precise circumstances under which, according to my experience, it should be employed." (Vol. i. pp. 563–5.)

The indications and contraindications for the use of tartar emetic are admirably presented. We wish, however, that the dangers of giving it to infants had been urged in more decided language. Its powerfully sedative and depressing action upon the system during the first year of life, is so great, that we are satisfied death has sometimes followed its incautious administration to children of a year old and younger. So great is this danger, that we should be inclined to prohibit its use altogether in persons of so tender an age. The heroic treatment of pneumonia and inflammatory affections of the chest, which was brought into vogue by Rasori and others of the Italian school, is properly condemned. "I am bound to express my own conviction," says Dr. Wood, "that the practice is on the whole not to be recommended." In saying this, we believe he expresses the conviction of most of our judicious practitioners. At the same time, the control of tartar emetic over pulmonary inflammation is fully admitted and explained, and its judicious use advised.

Among the subjects which we had marked for comment, are chloroform, alcohol, the use of heat as a stimulant, cod-liver oil, the use of quinia in rheumatism, travelling and exercise as therapeutic agents, and others. But we must bring our remarks to a close, and refer our readers to the book itself for Dr. Wood's views with regard to these and all other remedies of the materia medica. The latest reliable discoveries in therapeutics are incorporated into the work, and described with the exactness and precision characteristic of the author.

Dr. Wood closes his preface with the remark that this work will probably be his last professional treatise. "Advancing years warn him that the time is fast approaching when a failure of faculties, or the termination of life will render labour in any new field impracticable." We fervently hope that in both these points he is mistaken. Dr. Wood has not yet exhausted the stores of his experience. We trust that a hale and hearty old age awaits him, during which he may have the health and the leisure to draw from those stores, both for the benefit of the profession and the community.

In conclusion, let us commend the treatise heartily to the medical profession, and add as a parting word that the typography of the book is excellent. It is printed with a type and on paper, which is worthy of the subject, and highly creditable to the publishers. E. H. C.

ART. XVI.—*Human Physiology, Statical and Dynamical; or the Condition and Course of the Life of Man.* By JOHN WILLIAM DRAPER, M.D., LL.D., Professor of Chemistry and Physiology in the University of New York. Illustrated with nearly 300 wood engravings. New York: Harper and Brothers, 1856.

THE work whose title is at the head of this article, has been but lately issued from the press, and comes from the pen of one of the most original thinkers in this country. Before the work reached us, we felt confident that

it would contain much that was original and novel; and in this we have not been disappointed; perusing it with interest. But we must say that many of the new views, in our opinion, will not serve to advance the interesting and difficult study of physiology; and I might add, that it is likely to teach the student many things that he will have to unlearn, if he pay due regard to the facts daily developed in experimental physiology.

Everything that is novel in connection with the subject of physiology is of interest to the student of medicine, for there is scarcely any branch of his studies so attractive; professing, as it does, to make clear the inner structure of that body, which it is his aim to keep in order, and to repair when deranged.

"To the medical profession as matters now stand, nothing is of more importance than the discrimination of physiological knowledge. Empiricism could not flourish as it does, if the structure and functions of the body of man were nnderstood. . . . . . It would not only tend to a repression of empiricism, but would also exert an effect in raising the standard of acquirement among medical men themselves. That a great revolution is impending in the practice of medicine, no one who is at all observant of the progress of science can doubt. The great physicians of the future will be great physiologists." (*Preface,* vi.)

In this the author states what is true, but we fear that the happy day when empiricism is to pass from our midst is very far distant.

The novelty of the work before us is based upon its ultraism, treating the science of physiology as a branch of physics—the physics of man—in a more prominent degree than we are accustomed to. The author thus asserts his hopes:—

"For my own part, I have no sympathy with those who say of this or that physiological problem, it is above our reason. My faith in the power of the intellect of man is profound. Far from supposing that there are many things in the structure and functions of the body which we can never comprehend, I believe that there is nothing in it we shall not at last explain. Then, and not till then, will man be a perfect monument of the wisdom and power of his Maker, a created being knowing his own existence, and capable of explaining it. In the application of the exact science of physiology, I look for the rise of that great and noble practice of medicine which in a future age will rival in precision the mechanical engineering of my times." (P. 25.)

There will, no doubt, but very few be found as bold in their hopes as Dr. Draper, but much of this boldness is in part due to the manner in which he often regards the human body.

"A mere machine or engine, which acts in accordance with the principles of mechanical and chemical philosophy, the bones being levers, the bloodvessels hydraulic tubes, the soft parts generally the seats of oxidation. But if we limit our view to such a description, it presents to us man in a most incomplete and an unworthy aspect. There animates this machine a self-conscious and immortal principle—the soul." (P. 24.)

He even looks upon intellectuality as one of the results of the assimilation of food.

"In the organism of plants, the various compounds wanted by plants are fabricated. Animals destroy these compounds, and in so doing maintain a high temperature, irrespective of atmospheric conditions, and give rise to the phenomena of motion and intellectuality." (P. 37.)

In order that the author may not be misunderstood by the language he uses, we would state that in another portion of his work he looks on the *mind* without beginning and without end—the body being the instrument through

which it works, and according to the development or perfection of that instrument so are its phenomena. On this special head more will be said in another part of this review.

With these points prominently before him, the author endeavours to make the various facts of physiology, chemistry, and physics sustain the position, going a step in advance, or a step aside of the most advanced post in physiology; and, however much we may admire the boldness and ingenuity of the arguments, we cannot but see many fallacies, either as entertained by him or by others before him. And still further, we believe that many of those hasty generalizations introduced into modern physiology, from partial or imperfect results of chemistry, retard instead of advance the science, from the fact that an author, having once advanced a theory and become its advocate, is reluctant to abandon it, especially when new discovered facts in subverting his theory furnish none other to replace it.

Who does not remember the tenacity with which our fathers clung to the phlogiston doctrine, and still later to the compound nature of chlorine (oxymuriatic acid), for years after facts were known subversive of these views: the same is true of Lavoisier's theory of respiration, as beautiful as it is erroneous.

We are inclined to believe, with Prof. Lehmann, that enthusiasm in the cause of organic chemistry has degenerated, among many physiologists and physicians, into a fanaticism, which, even in the best cause, tends to invalidate a host of truths in its endeavours to uphold some single fact. In this way its most zealous partisans becoming its worst enemies.

But let us proceed to review certain portions of this work in order, and in many instances it will become necessary to notice views recognized by many of the leading physiologists of the day. In the first chapter on the conditions of life, there are several fundamental points that it would be well to examine into.

> "For the maintenance of the life of man, three chemical conditions must be complied with. He must be furnished with air, water, and *combustible matter*."[1] (P. 9.)
>
> "No article is suitable for food except it be of a *combustible nature*." (P. 16.)
>
> "The chief materials which a living being receives from the external world are, therefore, *combustible matter*, water, oxygen gas; and out of the action of these upon one another, all the physical phenomena of its life arise." (P. 16.)
>
> "An animal in this point of view is an oxydizing machine, into the interior of which atmospheric air is constantly introduced. The active constituent, oxygen, satisfies its chemical affinities at the expense of those parts of the system which are wasting away; and, as the act of breathing, that is, the introduction of this gas, takes place day and night, waking and sleeping, so too must the production of burned bodies—a part escaping by the lungs, a part by the skin, a part by the urine. To compensate the loss which ensues, nearly 1,000 pounds of *combustible matter* must be used in the course of a year." (P. 18.)

Without citing any more passages bearing on this point, we would remark that there is no term which appears to us so misused and abused by many physiologists, as that of *combustion*. Now this is a word which has a strict signification, recognized by general use as well as by chemists, and yet physiologists are constantly misapplying it, supposing that they thus establish some important generalization. Physiologists have been forced to see the difference between combustion and the chemical changes in the animal body,

[1] All Italics in this review are our own.

but, reluctant to abandon a theory where they have no other to fall back to, they think to obviate the difficulty by giving a new definition to combustion; and a word that, in common and chemical sense, signified *chemical action resulting in the production of fire (light and heat)*, whether oxygen take a part in the reaction or not, is now so corrupted by physiological use as to embrace all action between oxygen and a combustible body; if this be accepted, the definition of combustion cannot stop here, but must embrace all action between *chlorine, iodine, &c., and combustible bodies.* There is no such violent change occurring in the animal body that can be assimilated to combustion, and the sooner this term is changed to *molecular and chemical action,* the fewer the erroneous theories that will be likely to find their way into physiology. An evil arising from the adoption of this term, and applying it to the chemical changes in the animal body, is that it leads to crude generalizations and utter disregard to the complex nature of these changes. There is no author that has come under our notice who insists more strenuously than Dr. Draper does, in connecting combustion and combustible with the physiological changes in the animal body.

Why announce food as combustible matter? There is no doubt that much of it is so, if dried and brought in contact with oxygen under certain conditions. If, however, we are to understand by the use of the term, that food sustains animal existence by its combustible nature being rendered conspicuous, we take issue with the author, and shall allude to it more fully a little farther on. The statement is an erroneous one, for combustible matter cannot embrace the whole range of animal food any more than non-combustible can that of vegetable; mineral *non-combustible* constituents are as absolutely essential for animal life as albumen, fibrin, or casein, and thus the annunciation is imperfect—something more is necessary to sustain animal life than "air, water, and combustible matter." It is taking a narrow view of the physical and chemical wants of man to state it thus.

The following, from Carpenter, is a far more correct and rational manner of announcing the three essential material conditions of life: "*Food,* or substances capable of being converted into the solid portions of the organized fabric; *water,* for the maintenance of the due proportion of liquid in its constitution; and *oxygen* for promoting various changes in the assimilated matter, by which it is applied to a greater variety of purposes, and also for uniting with the particles destined for excretion, so that they may pass off in the form in which they can be most readily got rid of." Food must contain all the elements of the body, however they may be classified with reference to the action of oxygen. This is but a common necessity of plants as well as animals: and although the food of the former is for the most part non-combustible, it would be erroneous to make any such general announcement with reference to plants, for they do consume a combustible (ammonia) that appears essential to its existence and growth.

That no article but a combustible one forms any constituent of food is known by all to be erroneous; 'tis true, the larger part of food consists of carbon and hydrogen in various states of combination, yet it is equally true that many substances enter into the composition of our food belonging to a very different class of bodies. To exemplify this fact, let us take a mixed fluid, regarded as food *par excellence,* namely, milk, which is constituted of casein, fat, sugar, phosphate of lime, chloride of sodium, and other salts in solution and suspension in water; here, the non-combustible phosphates and chlorides are as essential elements of nutrition as the combustible materials casein and fat; for if the phosphates be absent, the infant will be but imperfectly sus-

tained, and death will as inevitably ensue, although not so speedily, yet as directly a consequence, as if the casein or other combustible were absent. To the physiologist, it must appear that the 40 per cent. of phosphate of lime in the bones is as important as the gelatin in the same parts, and that the $\frac{1}{10}$ per cent. of iron is as important to the blood as the 5 per cent. of albumen. Of the proximate principles of the animal frame, there are one hundred well defined, and of these, twenty-nine are inorganic, and such as would be classed as non-combustible—some forming portions of the tissues, some in the blood, and others in the excretions. Of these, eighteen enter the body from without, ready formed, and are assimilated.

It may be argued that these non-combustible constituents are introduced through the medium of combustible matter; that this is so, arises from the composition of the food, rather than that they must be so introduced. A carnivorous animal takes its requisite amount of chloride of sodium with the flesh that it consumes; an herbivorous animal is not furnished with it through the vegetable food, and it therefore eagerly seeks for the salt in the dirt and soil *unmixed with combustible food*, and assimilates it none the less readily from having so received it. There is nothing illogical in supposing that were milk deprived of its phosphates and chlorides, these salts artificially prepared would restore to it its requisite property.

Therapeutics furnishes many instances of the power of man to assimilate non-combustible materials introduced into the stomach; for instance, take a person suffering from chlorosis with the thin pale blood circulating through the body, introduce the oxide of iron into the stomach, the blood will deepen in colour, and the requisite proportion of iron be restored to the globules of that liquid; in fact, so far as we can judge, this oxide of iron has been assimilated by the animal body as truly as a bit of muscle or bread would be.

It is clearly the desire of the author in the leading chapter of his work to impress the student with the belief that the *fundamental* sources of the operations of the animal body have somewhat the simplicity of machinery, especially such form of machinery as the steam engine, whose source of motion lay in the action of oxygen on combustible matter.

This may appear as an unnecessary criticism of the views of the author—a review of mere words—when the details of nutrition are given more completely in other parts of the work, and where in his subdivision of food into four classes, he puts down the fourth as salts, saying :—

"Any classification of food-articles, which does not contain this group, is imperfect; for salts are not only absolutely essential to organic processes, but also to the construction of many tissues. As an example of the former case, the chloride of sodium may be mentioned, and of the latter the phosphate of lime." (p. 28.)

It is precisely because his generalization does not agree with the facts, even as he states them, that this point is reviewed so fully. When an author lays down a law or a rule, it is done to facilitate the student in his studies, and enable him even to divine facts without the necessity of acquainting himself with each one in detail. A student will be apt to recollect most easily the generalizations, and if erroneous, he errs accordingly. The sooner that the student is made to look upon man as something more than a mere machine put in motion by combustion, the sooner will he find himself on the path of true physiological knowledge.

In the second chapter, the nature of food is discussed, its sources and classification, and the author adopts to a certain extent the not unfrequent division

of food in two classes, "Histogenetic or tissue-making, and calorifacient or heat-making," but he very properly remarks—

"It is, however, to be distinctly understood that these divisions are only adopted for the sake of convenience, and that they have no natural foundation. Thus it will be found, when we examine the function which the fats discharge, that though they are non-nitrogenous bodies, and are, therefore, considered as belonging to the class of respiratory food, there is every reason to believe that they are essentially necessary to tissue development, and that the metamorphoses of nitrogenized bodies can only go on in their presence. They are, therefore, as truly essential to nutrition as are the latter substances." (P. 27.)

Classification of food has been a favourite subject of modern physiologists, from the fact that the mind of man aims constantly at generalizations, striving to obtain some simple rule to aid in exploring fields yet unforbidden to the experimenter. When Liebig and Dumas held forth so prominently to physiologists the aid of chemistry, they eagerly seized upon it with the facts and errors, and the attractive but often erroneous theories; and to many of them they still cling, notwithstanding, that more recent experimental researches disprove their possibility; for so averse is man to be without a cause that they will rather believe in a wrong one than to suppose they know none.

It has always appeared to us an assumption unsustained by facts that one class of food more than another is productive of the heat in animals, or that fat and sugar give rise more directly to the absorption of oxygen and formation of carbonic acid. Strange as it may appear, these views have been widely received without being supported in the facts of chemistry; all that the chemist can do in experimental research of this character, is to imitate, as near as possible, the physical and chemical conditions of the animal. Let us then view the matter in this way, and place a bit of muscle with interstitial fat, in contact with air at 100°, and follow the changes hour after hour; softening and decomposition will ensue, and examination will show that the muscular fibre is the portion acted on by the oxygen, giving rise to various allied compounds that are ultimately transformed into carbonic acid and ammonia. What becomes of the fat in the mean time? It resists the action of oxygen, or small portions become converted into butyric, caproic, or other acids, and so remain without undergoing further change; it is a well known fact that in many places of burial, the nitrogenous portions of the body are entirely decomposed under the action of oxygen and moisture, while the fats remain almost unaltered, or their acids have combined with the ammonia of the decomposing tissues to form adipocire, which resists decomposition.

Again, take a portion of milk and place it in contact with air at a temperature of 100°, decomposition soon commences, the sugar is changed (without absorption or loss of oxygen) into lactic acid and resists all further alteration; some little of the acid of the fats become changed into more highly oxidized acids, but the casein passes through a series of decomposition, terminating in carbonic acid and ammonia.

With these facts, the most natural conclusion appears to be, that if any portion of the food rather than another is to be regarded as undergoing in the blood that form of oxygenation giving rise to carbonic acid, it would be the albumen, fibrin, &c., rather than the sugar, fat, &c.; but the truth is, it is vain to attempt to settle the changes which occur in the body by experiments in our laboratories. One great difficulty in imitating these reactions outside of the body, is the complex nature of the animal fluids which must have a marked effect upon the nature of chemical reactions; it is a well known fact, in chemistry, that very slight alteration of the conditions under

which we present substances to each other modify materially their reaction; thus, tartaric acid dissolved in water decomposes the carbonates very readily, but when dissolved in alcohol has no action on them.

The chemist, in none of his operations outside of the animal economy, operates with liquids containing so many principles and so complicated in their nature. The complication of the circumstances with the want of stability of the constituents, renders it impossible for the chemist to foresee results, and he can only grope his way along by absolute experiment. We are not to suppose that the different principles have different chemical affinities in and out of the body, but simply, that the exercise of these affinities is very much modified, and that there is yet but little hope of imitating them artificially. In search of truth, it therefore becomes absolutely necessary to study organic chemical facts apart from those of pure chemistry. There are no experiments illustrating this in a stronger light than those of M. Bernard, with the salts of iron and ferrocyanide of potassium.[1]

Solutions were made of lactate of iron and ferrocyanide of potassium; these, when poured together, produce a Prussian blue; a portion of the iron solution was injected into the jugular vein, and shortly after followed by a portion of the ferrocyanide of potassium, no Prussian blue was formed; and, in killing the animal, a few hours afterward, no blue colour was found in any part of the body, neither in the stomach, lungs, nor urine; yet these two substances existed together in the blood, and their characteristic reaction could be made apparent by adding a strong acid to blood drawn from the body shortly after the injection of the liquids. Other experiments quite as striking, bearing on the same point, were made by this distinguished physiologist. It is well said that when we explain and predict in physiological phenomena unknown results in chemistry and physics, we commence where we ought to end. First of all, experiments should be made on the living animal—from them and them alone, true physiological results and deductions can be obtained; thus, with reference to the changes that sugar undergoes, we know, when introduced into the stomach, it becomes converted into glucose by catalysis, it enters the blood under this form, it is rapidly changed into lactic acid by catalysis of another nature, *and there our experiments cease;* we may suppose that it decomposes the carbonates, and in its turn becomes converted into carbonic acid and other products by absorption of oxygen or by reconstruction of its elements; all these may be possible, they have not been demonstrated, and to construct theories upon them may amuse, but may at the same time mislead.

There is no doubt that physiologists have to modify or abandon entirely their present view about fat as being only respiratory food; Prof. Draper, in alluding to the fat in the blood, admits this.

"The view heretofore taken that this class of substances is not histogenetic, but only respiratory, requires to be modified. There is reason to believe that the blood-cells themselves cannot be formed except in the presence of oil, which is also necessary to enable nitrogenized bodies to assume the ferment action. The nuclei of cells contain fats, as do also embryonic structures generally." (P. 123.)

"The fats are necessary in the production of fibrin, and for the nuclei of the cells; but, besides these histogenetic relations, they eventually, with the exception of the liver fat, undergo oxydation, and so minister to the support of a high temperature." (P. 125.)

But we must not be misled by this, from supposing that fibrin and albu

[1] Archiv. Gén. de Méd., vol. xvi. p. 224.

men, or their resultants, when they have fulfilled their histogenetic functions, do not equally undergo oxydation or other chemical decomposition developing heat. It may surprise some, when we assert that for the present we have no experimental authority for stating that this or that class of food serves more especially in giving rise to animal heat; and, notwithstanding that the author under review admits this in some measure, as seen by the last citations, yet, with the idea of combustion ever before him, in another part of his work, he would leave the reader under the impression that the fats are directly subservient to the respiratory organs; for, speaking of the lacteals, he says:—

"Correctly speaking, however, the lacteals are only lymphatics, which are taking up oil presented to them. In view of the use which the oils subserve in the animal economy, the lacteals are in reality an appendix to the respiratory system." (P. 88.)

"That the lacteals are connected with respiratory digestion, seems to be plainly indicated by the circumstance of their occurrence." (P. 88.)

Most physiologists, we think, will be reluctant to admit that the lacteals are to be regarded as an appendix to the respiratory system, any more than any other portion of the digestive organs. The food, whether absorbed by the stomach or by the lacteals, has yet to undergo further assimilation in the blood; and, with reference to the chyle, this becomes more evident when we regard the composition of this liquid, and see that out of 100 parts of solid matter contained in it, only 9 are fat, and 70 albuminous substances, arising from the digestion of nitrogenous food. With these facts to rely on, we cannot consent to the announcement that the "lacteals are only lymphatics to take up oil." It is somewhat surprising that the author should make the statement, when in other portions of his work he so clearly states what the lacteals really do take up; it can only be attributed to his effort to make to appear simple, processess that are in their nature complex.

It is true that the higher we mount in the scale of creation, the greater is the subdivision of organs for special results; thus, among the lowest orders of animals the exterior surface performs all the functions of kidney, skin, and lungs; an internal sac the whole process of digestion; while among the more elevated, many organs supply the place of these two; yet even man is far from having a separate organ for every single end. The salivary glands furnish liquid to enable us to swallow our food; it also imparts certain chemical action to a portion of it—the stomach is both a digestive organ and an absorbing surface, and so the lacteals are not to be set down as expending their entire force, or even the greater portion of it, in the absorption of merely fat, and that all other absorption by them is but complementary.

From this we will pass to the subject of the blood and respiration. There is one matter connected with the composition of the blood that most treatises on physiology misstate, or leave the reader under an erroneous impression, which Dr. Draper has but slightly touched upon: it is in reference to the gaseous constituents of the blood. Ask most students, and I might even add the profession at large, whether it is in venous or arterial blood that the greatest amount of free carbonic acid is to be found? and the answer will be, the venous, of course! and if inquiry be further made as to who is the most reliable authority on this subject, we will be told Magnus. In fact, if we refer to *Müller's Physiology*, p. 345, Lond. ed., 1839, it reads thus: "Both kinds of blood contain carbonic acid gas; venous blood contains most carbonic acid gas—arterial blood most oxygen;" yet he gives Magnus' results; which are

reproduced here from the original memoir,[1] with an additional column, giving the proportion of gas contained in 100 parts of blood. As the experiments were made with varied proportions, it is necessary to have this for a clear view of the subject:—

VENOUS BLOOD.

	Quantity of blood in centimetres.	Carbonic acid.	Oxygen.	Nitrogen.	Reduced to contents in 100 parts of blood. Carbonic acid.	Oxygen.	Nitrogen.
Horse . .	125	5.4	1.9	2.5	4.3	1.5	2.0
" . .	205	8.8	2.3	1.1	4.3	1.2	.5
" . .	195	10.0	2.5	1.7	5.1	1.3	.9
" . .	170	12.4	2.5	4.0	7.3	1.4	2.3
Calf . .	153	10.2	1.8	1.3	6.6	1.2	.9
" . .	140	6.1	1.0	0.6	4.3	.7	.4
			ARTERIAL BLOOD.				
Horse . .	130	10.7	4.1	1.5	8.2	3.2	1.1
Calf . .	123	9.4	3.5	1.6	7.6	2.8	1.3
" . .	108	7.0	3.0	2.6	6.5	2.8	2.4

From the above, it will be seen that, twenty years ago, Magnus proved by a series of experiments, the most ingeniously devised and skilfully executed of any experiments ever made upon the blood, that arterial blood not only contains more oxygen than the same quantity of venous blood, but also more carbonic acid in solution. We know of but two or three physiologists who have noted these facts aright, and the consideration of them is of the utmost importance in a truthful examination of the phenomena of respiration, in a manner to be mentioned a little further on.

We would not review what Dr. Draper says on the subject of the action of air on the blood, did we not conceive that experimental results are proving that oxygen has a complex action on the blood, one likely to shake our faith in the much admired simple theory. The following is a common view, as stated by the author:—

"The cells, which constitute the other chief portions of the blood, are necessary to the production of a high temperature, by constantly transferring oxygen from the cells of the lungs to every part of the body . . . . the plasma serves, therefore, for the general nutrition of the system, and the disks, by transferring oxygen from point to point, discharge that part of their duty which is connected with the production of heat." (P. 126.)

This narrow action of that curious agent, oxygen, will be more and more disproved every day. The blood cells absorb it—of that there can scarcely be a doubt—but are we to suppose that the albuminoid, fatty, and other matter in the plasma of the blood are not altered and assimilated by it, as it is carried by the cells through the mass, giving rise to the many different forms of substances requisite for the muscular, nervous, tendinous and other tissues, for the bile and other secretions, &c.? We are of the opinion that the great and immediate result of oxygen in the blood, is to complete the assimilation and structure of the dissolved food that enters it, and to aid in the necessary alteration of the exhausted tissues that are to be removed from the body. Dr. Draper admits its importance in changing albumen into fibrin. The change of the constantly-forming sugar of the liver into lactic acid is due to the presence of oxygen in the blood, and, no doubt, when experimental results enable us to penetrate further into the mysteries of the action of oxygen, the present

[1] Annales de Chimie et de Phys., 1837, vol. lxv. p. 185.

prevailing notions will be materially altered. Until then, we must grope along with the feeble light we have, or be misled by the *ignis fatuus* of a plausible theory.

If we are to take the teachings of physiologists of which Prof. Draper is a type, the oxygen must be looked upon as serving almost exclusively for the production of animal heat.

"Reduced to its ultimate conditions, the evolution of animal heat depends on the reaction taking place between the air introduced by respiration and the food, and as either one or other of these is touched, the result may be predicted." (P. 182.)

"In every instance, we assert that the production of animal heat is due to oxidation taking place in the economy, and giving rise to carbonic acid, water, and other collateral products." (P. 182.)

"If there be abstinence from food, since the introduction of air by respiration goes on without abatement, the body itself must undergo oxidation, lose weight, and emaciation occur." (P. 183.)

Although we admit that most, if not all, animal heat is derivable from chemical agency, we cannot admit that the simple statements above convey any adequate idea of the nature of those chemical changes. The author would lead us to suppose that oxygen alone acts in the production of animal heat by a perfect destruction of the substance acted upon, resulting in the formation of carbonic acid and water, and, still further, that this action is between the air and food which enters the blood, and that it is not until the food in the blood is exhausted that the oxygen expends itself upon the tissue of the body.

What are the facts that warrant these conclusions? Oxygen is taken into the circulatory system through the lungs, and carbonic acid and water evolved. Is it not equally true that certain portions of the food and water are taken into the circulation through the coats of the stomach, and from the same surface gastric juice is thrown off? *The lungs, like the stomach, perform a double action, without there being necessarily any immediate connection between those actions.* This much we know, that the changes in the blood and tissues give rise to liquids (embracing solids in solution) and gases. These pass from the blood either as secretions or excretions, and, as the various organs are adapted, so do they operate. The liquids pass through the liver, kidneys, stomach, &c.; the gases through the lungs, skin, and intestines; and, according to the special adaptation of these, so do they predominate in their activity of this function. Carbonic acid gas passes off most readily from the lungs, because the displacement action of the air acts more readily through the delicate membrane of the air-cells than through the thick skin, and as the skin becomes more delicate in animals, so does the amount of carbonic acid discharged in this way increase. Much of the carbonic acid in the blood, doubtless, arises from processes analogous to fermentation; and this conclusion is a rational one, when we consider that the proximate principles of the animal body are usually composed of a large number of atoms of four or five elements, so that small causes may decompose them, and rearrange the multitude of atoms under new forms.

So far as the development of heat is concerned by the agency of oxygen, it matters not whether that element combines with certain substances to form uric acid, urea, creatine, &c., or with fat and sugar to form carbonic acid and water, it is a well established fact that the amount of heat generated by oxidation does not depend on its character, or on the resulting products, but simply on the amount of oxygen that is combined. Physiological experiments are leading us more and more to the conclusion that oxygen has a vast deal to do in the blood, and of more importance than burning up sugar and fat.

We hold no particular theory about the precise manner in which oxygen acts to produce heat, all that we insist on, is not to imagine operations unsustained by facts or analogy.

The following views of Regnault, in regard to the chemical phenomena of the animal body, are certainly correct:—

"The study of chemical reactions in our laboratories, and in vessels which take no part in the phenomena, are very different from the study of those which take place in organized beings; here the chemical reactions take place in vessels the matter of which most commonly participates in the changes, and thus render the phenomena incomparably more complex. . . . . . It is very probable that animal heat is produced entirely by chemical reactions that take place in the economy, but the phenomena are too complex for us to calculate it from the quantity of oxygen consumed. . . . . . Besides, in all the transformations and assimilations of substances which take place in the organs, there is disengagement or absorption of heat; but the phenomena are so complex, that there is little probability that we will ever be able to submit them to calculation."

In treating of the escape of carbonic acid from the lungs, Dr. Draper has overlooked the recent experiments of M. Verdeil which have such a direct bearing on this subject. It is surprising that it should not have been observed sooner that the tissue of the lung was acid. Verdeil obtained a peculiar acid from it, which he called *pneumic acid.* Uric acid has since been found in small quantity.

This acid condition of the lungs must bear directly upon the passage of free carbonic acid into the lungs. The blood enters the lungs alkaline, with bicarbonates and some free carbonic acid, it comes in contact with an acid tissue, and is it not a most natural conclusion that the acid of the lungs should set free some of the carbonic acid in combination with the alkali, and thus put it in a more favourable condition for passing into the air-cells of the lungs? Yet further, this liberation of free carbonic acid is the only way we can explain the larger amount of this gas in the arterial over the venous blood (and that just after the blood had come from the lungs), exhibited by the experiments of Magnus recorded on a previous page. It may be asked, how does this account for it? The venous blood comes from the right heart to the lungs, much of its carbonic acid exists in combination that will not admit of its passing in the air-cells by the mechanical actions which are in play to bring it about, but the acid of the lungs soon obviates this difficulty, by combining with a portion of the alkali, liberating carbonic acid. The blood in the extreme capillaries thus has a large increase of free carbonic acid, a portion of which passes into the cells of the lungs—but yet not all the excess—and the blood finds its way to the left heart, oxygenated by absorption from air, but yet with more *free carbonic acid* than it had when it entered the lungs. The blood is now distributed to the tissue, and this excess of carbonic acid may in part combine with alkalies, &c.

One of the most marked set of experiments ever made, that sustain this view, were made by M. Bernard prior to any discovery concerning the acid of the lungs; and, at the time they were made, the author attributed the results to some catalytic action of the tissue of the lungs; but they are now explained by a very simple and natural chemical decomposition. The experiments are so striking that we will give a statement of them here.[1]

The first experiments were with cyanide of mercury, which, when mixed with gastric juice, underwent decomposition, giving rise to free hydrocyanic

[1] Archives Gén. de Méd., vol. xvi., 1848, p. 219.

acid; if, however, it be mixed with blood, no free hydrocyanic acid is formed. When this salt was introduced into the stomach, poisonous effects of hydrocyanic acid were soon apparent, the animal dying under the well-known effects of this poison. When the same salt was introduced into the blood, the same effects resulted, and the tissues gave out the odor of hydrocyanic acid. The last fact arrested the attention of M. Bernard, and this philosopher and physiologist, "seeing that the blood did not decompose the cyanide of mercury, and knowing that acid disengaged it freely, it was reasonable to suppose that, after it was introduced directly in the circulation by the veins, the cyanide of mercury was afterwards carried into organs where it would encounter acid liquids capable of decomposing it, and giving rise to hydrocyanic acid, which killed the animal; the organs may be the kidneys or stomach. In fact, if we mix cyanide of mercury in the acid urine of a dog, either in the kidneys or in the bladder, decomposition manifests itself in a few moments. The acid coats of the stomach act in the same manner, and I have already proved that substances injected in the blood could pass easily into the gastric secretion." To test whether or not this was so, an experiment was made, in which all the acid secretions were suppressed.

The abdomen of a small sized dog was opened, the stomach, kidneys, and bladder were extirpated, the proper ligatures being applied. Shortly after this operation, cyanide of mercury was injected into the femoral vein, and in half a minute respiration became difficult, the animal soon died in convulsions, exhaling from its throat a strong odor of hydrocyanic acid, and on being dissected, all parts of the animal were impregnated with the same odor, and none of the liquids or the body were found acid. In this experiment the cyanide was decomposed as rapidly as when all the organs were intact.

The source of the decomposition was thus reduced to the tissues; as to the muscular tissue, it was tested by injecting the cyanide into the femoral artery and examining the blood of the femoral vein, which gave no odor of hydrocyanic acid, but contained the cyanide which was immediately decomposed by the addition of a like hydrochloric acid. The result was very different when the cyanide was injected into the femoral vein; in less than a minute the animal died, exhaling from the throat a strong odor of hydrocyanic acid.

It became very evident that the decomposition took place in the lungs and when pieces of muscle, skin, liver, and lung were placed in a solution of cyanide of mercury, the lung alone decomposed it. Bernard, in stating the fact says: "*Thus the cyanides, in passing through the pulmonary tissues, are decomposed as if submitted to the action of an acid.*" This is put in Italics, as it was remarkable that he did not suspect the acid character of the lung, attributing it to a catalytic action; and it was not until three years afterwards that Verdeil discovered the acid of the lung. Bernard, at the time he made the experiments with the cyanides, says, *that certain bicarbonates are also decomposed in the blood at the moment this fluid traverses the lungs.*

"For this purpose all that is necessary is to inject rapidly in the jugular vein a solution of bicarbonate of soda; very soon the animal dies, and on examination the lungs are found to be emphysematous and distended. There exists gas in the largest branches of the pulmonary arteries, and sometimes even in the ventricle of the heart. This gas could only have arisen from the decomposition of the bicarbonate, and the animal dies as when air is introduced into the veins. It is, however, very easy to avoid killing the animal by introducing the solution of bicarbonate very slowly; it thus happens that, in passing little by little into the lungs, it is gradually decomposed, so that the carbonic acid can be dissolved in the blood and not arrest the circulation, as happens when much gas is introduced at once."

In conclusion, the experimenter remarks: "We see that certain substances, as the cyanides and bircarbonate, which usually require the intervention of an acid to decompose them, can nevertheless be decomposed in the alkaline blood. But to effect this decomposition, *the lung is necessary, which appears to be the special locality of that kind of chemical change.*"

When it is remembered that the above experiments were made without reference to any preconceived notion or ultimate theoretical application, they become of great value in our physiological studies. Here we find an author trying to find the source of chemical change which under ordinary circumstances require an acid, he finds himself conducted to an organ which he did not suppose was acid.

These facts of Bernard are made to occupy some space, from the fact that they are not alluded to in the physiology under review, and because physiologists can no longer disregard them, in connection with M. Verdeil's discovery of pneumic acid, when treating of escape of carbonic acid from the lungs.

Under the subject of secretions, Dr. Draper lays some stress on their preexistence in the blood, and their passage into the glands by a process of exudation; he does not, however, entirely repudiate the idea that the cells in some of the glands perform a part in the necessary metamorphoses; his views on the subject are embraced in the following paragraph :—

"The cases in which the influence of cells is indisputable, are those which offer to us combinations of progressive metamorphoses. Of these, the most striking instance is the preparation of the spermatic fluid. Perhaps we should not be very far from the truth if we consider all those secretions in which the materials are in a state of retrograde metamorphosis, or in a descending career, as arising by mere filtration, and those which are ascending to a higher grade as due to cell agency; between the two, there being an intermediate class, the phase of which is stationary, and in which cells may or may not be necessarily involved, as for instance, the transmutation of one fat into another, or the preparation of sugar from albuminoid bodies." (P. 192.)

We should say nothing more on this subject did not the author, under the head of special secretions, classify among those formed in the blood, some which we do not think are thus formed; as, for instance, the bile.

"I therefore regard the bile as an excretion of materials which are decomposing and ready to be removed from the system. I incline to the supposition that much of it is derived from the cells of the blood, the life of which is only temporary." (P. 203.)

"In any discussion of the action of the liver, it is thus to be constantly borne in mind that the portal blood consists of two portions, systemic venous blood and matters absorbed from the digestive apparatus. Derived from the first of these portions, we trace the origin of the bile to waste of the tissues, or to the blood-cells on their downward career; and hence we arrive at the important conclusion that every proximate constituent of the bile pre-exists in the systemic venous blood." (P. 203.)

This is contrary to all direct experiments on the subject, as those of Müller and Kune. Arrest the action of the liver in any way whatsoever, and bile does not exhibit itself in the blood; also in certain diseases, as fatty degeneration of the liver, where its cellular structure and functions are profoundly effected, we have no evidence of bile in the blood. Were the bile formed in the blood, the contrary should occur, as in the case of urea, which is proved to pre-exist in the blood. If the kidneys be extirpated or the action be suppressed by fatty degeneration or otherwise, urea increases in quantity in the blood and other parts of the body, as the skin and intestines, that eliminate it to a certain extent.

So far as we are borne out by experimental facts, there is no reason for supposing otherwise than that the cell action of the liver forms bile as well as sugar and fat; it is an organ whose functions are of the utmost interest to the physiologists, who have been amply repaid for their recent experimental investigations of it.

The peculiar properties of endosmose and exosmose are attributed entirely to capillarity, which we know is altogether untenable, and is so considered by the leading authors on this subject; but we cannot stop to review this now, nor the new theory of the circulation of the blood, which was first advanced by Dr. Draper about ten years ago; we examined it with much care then, and have often recurred to it since, but could never be convinced of the truth of it, from it being at fault in its very basis, namely, the capillary attraction in the terminal extremities of the veins and arteries. The fact is, we cannot see how any capillary attraction can occur under the circumstances, but as this involves a more complete review of capillary attraction than this article would warrant, we will have to pass it over, and probably recur to this special question on another occasion.

We would have been pleased to have had more said about the electric currents in the human body as developed by the interesting experiments of Matteucci and Raymond Du Bois.

Prof. Draper, treating physiology as a branch of natural philosophy, divides it into statical and dynamical physiology: "the one including the conditions of equilibrium of an organized form, the other those of its development—development being no more than its motion."

This division is doubtless a very philosophic one, and may lead to useful results, if due precaution be used in not burdening the statical portion with imperfect and ill digested theories, which only serve to heap up confusion and retard the true progress of dynamical physiology, fraught as it is with as much interest and obscurity.

There is much in this part of the work that we should like to review, either from the novelty of its nature or novelty of the manner in which it is advanced. We will, however, remark principally upon the author's views of the agency usually known as vitality or vital agency, and his ideas of progressive development, which are as extravagant as those of Lamark, or the author of the *Vestiges of Creation.*

He thinks proper to abandon the use of the term vitality, or vital agent, and supplant it by the use of the term "plastic power," or power of arrangement.

"The preceding elementary examination of the circumstances under which plants grow, has led us to the inference that in their germ there resides a plastic power, whose function is to model the organic matter, as it is furnished by the sunlight, into definite shapes or organs." (P. 468.)

"Are plants, in truth then, nothing more than temporary states through which material substance is passing (because of some original physical impression made upon it), and the present operation of external circumstances? Can individuality be applied to them any more than to a flame? Instead of being individuals, are they not rather the transitory results of an operation?" (P. 470.)

"The organic series—an expression which is full of significance and full of truth, for it implies the interconnection of all organic forms—the organic series is not the result of numberless creative blunders, abortive attempts, or freaks of nature. It presents a far nobler aspect. Every member of it, even the humblest plant, is perfect in itself. From a common origin, a simple cell, all have risen; there is no perceptible microscopic difference between the primordial vesicle which is to produce the lowest plant, and that which is to produce

the highest; but the one, under the favouring circumstances to which it has been exposed, has continued on the march of development; the career of the other has been stopped at an earlier point. The organic aspect at last assumed, is the strict representation of the physical agencies which have been at work. Had these for any reason varied, that variation would at once have been expressed in the resulting form, which is, therefore, actually a geometrical embodiment of the antecedent physical conditions. For what reason is an offspring like its parent, except that it has been exposed, during development, to the same conditions as was its parent." (P. 466.)

Nor is this plastic force (as we understand it, the cell-forming force) at all different in the vegetable and animal creation; whatever may be the difference of ultimate form, it is due to external circumstance.

"All animals, no matter what position they occupy in the scale of nature, unquestionably arise in the first instance from a cell, which, possessing the power of giving birth to other cells, a congeries at last arise, the size and form of which is determined wholly by external circumstances. In all cases, the material from which these cells are formed is obtained from without; and, whatever the essential shape of the structure may be, the first cell is in all instances alike. There is no perceptible difference between the primordial cell, which is to produce the lowest plant, and that which is to evolve itself into the most elaborate animal.....The germ which produces a lichen, obtains from materials around it the substance it wants as best it may; but the germ which is to end in the development of man is brought in succession under the influence of many distinct states." (P. 489.)

All that the author says goes to show that all primordial cells are under the operation of the same plastic force, without any innate capacity of pursuing a fixed course, yet he admits that the cell will develop itself into the likeness of its parent if submitted to the same condition through which its parent passed. We would here stop and ask, how can this be true and all primordial cells be looked upon alike? The very fact, that of the respective cells having a capacity to assume the form of the parent under any circumstances, proves that there is a special directive force in all cells according to their origin.

Adopting the views already mentioned, Prof. Draper has for consistency's sake to adopt the doctrine of progressive development in all its length and breadth.

"Starting from a solitary cell, development takes place, and, according as extraneous forces may be brought into action, variable in their nature, and differing in their intensity, the resulting organism will differ. If such language may be used, the aim of nature is to reach a certain ideal model or archetype. As the passage towards this ideal model is more or less perfectly accomplished, form after form, in varied succession, arises. *The original substratum or material is in every instance alike; for it matters not what may be the class of animals or plants, the primordial germ, as far as investigation has gone, is in every instance the same. The microscope shows no difference, but, on the contrary, demonstrates the identity of the first cell, which, if it passes but a little way on its forward course, ends in presenting the obscure cryptogamic plant, or, if it runs forward toward reaching the archetype, ends in the production of man.*" (P. 506.)

The microscope is expected to unfold the secret mysteries of the germ, and if it shows none between that of a cryptogamic plant and that of man, then the germs are identical; as well might the chemist say there was no difference between a bird and a dog, because chemical analysis showed them to be alike in constitution. The author does admit that there is something in the cell, a condition at least of "plastic force," to which neither chemistry, nor physics, or the microscope could conduct him—how does he arrive at it, then? by its effects only—and in the same way we see more than that in cells—we see

them developed in different directions, even when submitted to the same conditions (a grain of wheat and an apple seed placed side by side in the ground), and therefore conclude that there is a peculiar directive force to each class of primordial cells.

The author's views are not advanced without supposed proofs being adduced to sustain them, and to review them all would be going over the ground that many have done before us, and besides, we would transcend the limit allowed; but one or two of these will be mentioned:—

"Thus man himself, in succession passes through a great variety of forms, from the condition of a simple cell; these forms merging by degrees into one another, the form of a serpent, of the fish, of the bird, and this not only as regards the entire system in the aggregate, but also as regards each one of its constituent mechanisms—the nervous system, the circulatory, the digestive. Now, in the passage onward, these forms are to be regarded, as has been well expressed, each one as the scaffolding by which the next is built; and just as man, in his embryonic transit, presents these successive aspects on the small scale, so does the entire animal series present them in the world on a great scale." (P. 507.)

"Without going into tedious details, man presents, as regards the most important of his constituent structures, his nervous system, the successive characteristics of an avertebrated animal, a fish, a turtle, a bird, a quadruped, a quadruminous animal before he assumes the special human characteristics. This is his cycle of life." (P. 513.)

Add to this the example of other animals, as the frog and the moth, which pass through two or three different forms, and we have the character of facts advanced to sustain this strange doctrine.

As regards the changes of a frog or moth from a tadpole or caterpillar, they are but stages in the life of one animal, there is no complete organism until all these changes are accomplished. A tadpole may remain such for a considerable length of time, but never becomes a complete organism; it cannot produce a germ; its utmost capacity is to be changed to a frog and nothing else; the same is true of the caterpillar; in these forms they resemble other animals, to be *like them*, they must go over an impassable gulf—in these we are dealing with embryos, and not animals.

As to man having successive characteristics of the serpent, fish, bird, &c., he never is like either of these animals mentioned, no imaginable arrest of development could make a fish or a serpent of a man, he would be a miserable specimen of either, and never could be classified with any perfect organism. It is clear that whatever similitudes a man has in his embryotic condition, there is but one point that it can stop at—that is man.

But we must leave this part of the subject without our conviction being in the least shaken, that every cell, primordial or otherwise, has its specific endowments.

The boldness of the author does not stop with his views of the gradual development and perfection of the organic kingdom, but he would seek in the nervous structure proof positive of the existence of a soul and of its immortality. The principal of his arguments are based on an inverse reasoning from one set of known facts; thus, giving the nature of light to determine what must be the structure of the organ of vision; or, giving the construction of the eye to determine the nature of light; presuming that this and similar facts can be made out, the author goes on to say:—

"Given, the structure of the cerebrum to determine the nature of the agent that sets it in action. And herein the fact which chiefly guides us in the absolute analogy in construction between the elementary arrangement of the cere-

brum and any other nervous arc . . . if the optical apparatus be inert, and without value save under the influence of light—if the auditory apparatus yield no results save under the impression of sound—since there is between these structures and the elementary structure of the cerebrum a perfect analogy, we are entitled to come to the same conclusion in this instance as in those, and, asserting the absolute inertness of the cerebral structure in itself, to impute the phenomena it displays to an agent as perfectly external to the body, and as independent of it as are light and sound, and that agent is the soul." (P. 285.)

"The principle which obscurely animated the germ, is the same which in a higher way animates the embryo, and this again is the same which, in a more exalted condition, animates the infant and the man. The cloudy speck which ushers in the phantasmagoria of life expands as the great Artist directs, until every lineament has become visible."

"That active agent which was first laid in a fold of the germinal membrane was not annihilated when its type of life was changed to placental, and therefore aquatic respiration. It withstood the shock when again, after a due season, it was suddenly made to breathe the air. Arrived at the mature condition, there is not in its companion body a single particle that was present at birth. All has changed. And, what is still more important, not only has there been interstitial removal, but, in succession, the very nature of every one of its organs are changed. It is needless now to repeat how many different systems of nutrition it has depended on—how many sorts of stomachs in succession it has had—how it has breathed by a membrane, by gills, and by lungs—how it has carried on its circulation, without a heart, with a heart of one cavity, and finally with one of four. Through all these losses and changes the immaterial principle has passed unscathed, and even gathering strength. In the broadest manner that a fact can be set forth, we see herein the complete subordination of structure and the enduring character of spirit. Whatever may be the mechanism that is wanted, it is in readiness for its time; and when it has finished its duty, is neglected and disappears. There is, therefore, a sound reason in the conclusion to which mankind, perhaps from a mere instinctive impression, have come, that the soul will exist after death, for, after surviving so many mutations, the removal of so many of what seemed to be its firm and essential supports, we are justified in expecting that it will bear without ruin the entire withdrawal of the whole scaffolding." (P. 549–50.)

We have thus quoted from the author, to give the reader some ideas of his views as regards the existence and immortality of the soul, and we leave it to the reader to reflect how far his arguments may warrant the conclusions.

The chapter on the races of man and his intellectual qualities has many points of interest; he adopts the doctrine of the unity of the races, advancing the usual arguments to sustain its position.

With these views we leave Dr. Draper's work, and feel assured that any one reading it will be much entertained and instructed; although they will find much in it, as set forth by this review, which it will not be safe to adopt—especially his generalizations—which are usually too broad, and much simpler than the complicated facts admit of.

The style in which the work is composed we can speak of in the highest terms, and its typographic execution has seldom been surpassed by that of any medical work issued from the press of this couutry, and the wood-cuts are unequalled. J. L. S.